Case Report

Nonpuerperal chronic endometritis with pyometra causing systemic illness in a production sow

Celeste Morris,[a,*] Katherine Watson,[b] Diana Schwartz,[c] Richard Pereira[d]
[a]William R. Pritchard Veterinary Medical Teaching Hospital, School of Veterinary Medicine, University of California, Davis, CA, USA
[b]California Animal Health and Food Safety Laboratory System, School of Veterinary Medicine, University of California, Davis, CA, USA
[c]Veterinary Diagnostics and Preclinical Research Services, Davis, CA, USA
[d]Department of Population Health and Reproduction, School of Veterinary Medicine, University of California, Davis, CA, USA
*Current address: Veterinary Health Center, University of Missouri College of Veterinary Medicine, Columbia, MO, USA

Abstract

A second parity, late pregnant, commercial mixed-breed sow was examined on a farm with a 5-day history of inappetence and lethargy that was unresponsive to treatment with flunixin meglumine. Clinical signs were suspected due to an enlarged, fluid-filled hollow abdominal organ identified via transabdominal ultrasonography. Further characterization of abdominal viscera and fluid was limited by the sensitivity of the imaging equipment. Flunixin meglumine was discontinued and a dietary supplement was added to the feed to encourage intake. Repeat transabdominal ultrasonography was performed 4 days later due to a lack of improvement with worsening lethargy, continued inappetence, and fever. The sow was euthanized because of poor prognosis, chronicity of disease, and lack of pregnancy. On necropsy, the uterine horns measured 20 cm in diameter and occupied ~ 80% of the abdominal cavity, compressing the intestines and liver. The uterine lumen contained watery, turbid fluid. The left ovary had multiple grossly appreciable corpora lutea, and right ovary had multiple corpora albicantia. Although uterine disease is poorly defined in swine, based on the gross and histologic findings this sow was diagnosed with nonpuerperal chronic endometritis with intrauterine accumulation of purulent fluid (consistent with pyometra). Additionally, the sow was diagnosed with salpingitis, interstitial nephritis, lymphadenitis, and gastric ulceration, all likely contributing to her declining health and systemic illness.

Keywords: Sow, pyometra, endometritis, transabdominal ultrasonography

Background

Reproductive diseases are one of the most frequently reported reasons for culling in the swine industry. Early recognition and treatment of urogenital disorders are essential to optimize sow reproductive performance; however, to maintain economic efficiency, sow culling for decreased performance is a widely recognized herd health management strategy. Thus, uterine diseases in sows, including pyometra, endometritis, and metritis, remain poorly characterized. This case demonstrates the need for a more concrete classification and characterization of uterine diseases in swine. Our goal is to review the current literature and compare uterine inflammatory conditions in sows with other common domestic species.

Case presentation

A second parity, commercial, mixed breed sow was examined on a farm with a 5-day history of decreased appetite, lethargy, and lack of response to treatment with flunixin meglumine. The sow was bred 88 days before presentation and was due to farrow in 28 days. She was diagnosed pregnant (transabdominal ultrasonographic visualization of fluid-filled uterine cross sections) between 30 and 40 days of pregnancy. She exhibited no outward signs of return to estrus and had no other abnormal systemic health signs or concerns until this time. The sow was lethargic and reluctant to move but was responsive to environmental stimuli. Her heart rate and temperature were within normal limits (80 beats per minute and 100°F,

CONTACT Celeste Morris **c.morris@missouri.edu**

Citation line: Clinical Theriogenology 2023, 15, 9806, http://dx.doi.org/10.58292/CT.v15.9806

respectively). She was eupneic. Cardiac and thoracic auscultation were within normal limits. Her eyes, ears, nose, and throat were symmetrical. No ocular or nasal discharge was noted. Brief neurologic, musculoskeletal, and integumentary examinations were within normal limits. Her abdominal contour was normal. She had a body condition score of 3/5. Her vulva appeared normal with no discharge. No feces or urine were visualized. Peripheral lymph nodes were not visually enlarged. A brief transabdominal ultrasound performed with a handheld, on-farm ultrasound (KeeboVet WED-2000AV, Mount Prospect, IL) used for routine pregnancy diagnosis revealed a hollow viscera distended with fluid. No other abnormalities were noted. Although fetal parts were not observable (due to ultrasound equipment with limited diagnostic imaging capability), it was suspected that sow was pregnant given the large fluid-filled loops (5–7 cm in diameter). At this stage of pregnancy, with a machine of better imaging capability, visualization of bony structures (ribs, spine, long bone, or skull) and/or heartbeats is possible. Top differential for inappetence and lethargy were gastric ulceration resulting from stress, systemic effects, nonsteroidal antiinflammatory drug treatment, and/or discomfort from an enlarged, late pregnant uterus. Recommendations after this visit included monitoring for progression of clinical signs and alterations in overall condition, including fever, lameness, depression, vomiting, or inappetence, in addition to giving Ensure® (Abbott Laboratories, Chicago, IL) to increase caloric intake. Other treatments for gastric ulceration were declined due to logistical challenges, financial constraints, and meat withdrawal concerns.

The sow was examined 4 days later because of a decline in her overall condition. She remained lethargic and refused her normal commercial diets despite consuming the recommended Ensure®. The sow was dull and more reluctant to move than at the previous visit. Her temperature was 103.2 °F, pulse was 100 beats per minute, and breaths were normal (12 breaths per minute). She had developed moderate abdominal distention, was lame on her left rear limb, and had brownish mucoid feces. All other systems were unchanged from the previous visit. Transabdominal ultrasonography performed with a multi-species machine (Ibex Pro, Loveland, CO) revealed numerous distended loops of hollow viscera varying in diameter from ~ 4 to 10 cm, containing homogenous hyperechoic fluid (Figure 1). This ultrasound equipment allowed clear visualization of the fluid and definitive determination that that there were no detectable fetuses, fetal parts, or fetal remains. It was undetermined whether this hollow abdominal organ was part of the gastrointestinal tract or uterus. Differential diagnoses for multiple loops of distended bowel included lower gastrointestinal blockage (partial or full), torsion, or intussusception. Top differential diagnosis for a distended uterus lacking fetuses was uterine infection, including endometritis, metritis, or pyometra. A transcutaneous fluid sample was taken that yielded a yellow to white turbid fluid (Figure 2B). Ovaries could not be visualized during an ultrasonographic examination.

Outcome

The sow was euthanized due to poor prognosis, chronicity of disease without improvement, and a lack of viable pregnancy. Prostaglandins used to evacuate uterine fluid and/or antibiotics were discussed, but due to chronicity of disease, uncertainty surrounding the fluid-filled viscous organ, and unlikely return to full reproductive productivity, these therapies were not elected.

Postmortem findings

Uterus: closed pyometra with severe plasmocytic and lymphocytic endometritis and distal salpingitis with marked intraluminal purulent fluid and neutrophilic exocytosis

Left ovary: multiple corpora lutea and albicantia

Right ovary: multiple corpora albicantia

Lumbar lymph nodes: lymphadenomegaly

Kidney: mild, multifocal, lymphoplasmacytic interstitial nephritis with tubular ectasia, red blood cell casts, and tubular thyroidization

Stomach (pars esophagea): regionally extensive erosion

Uterine horns measured 20 cm (~ 7.87 cm in diameter) and occupied ~ 80% of the abdominal cavity, compressing the

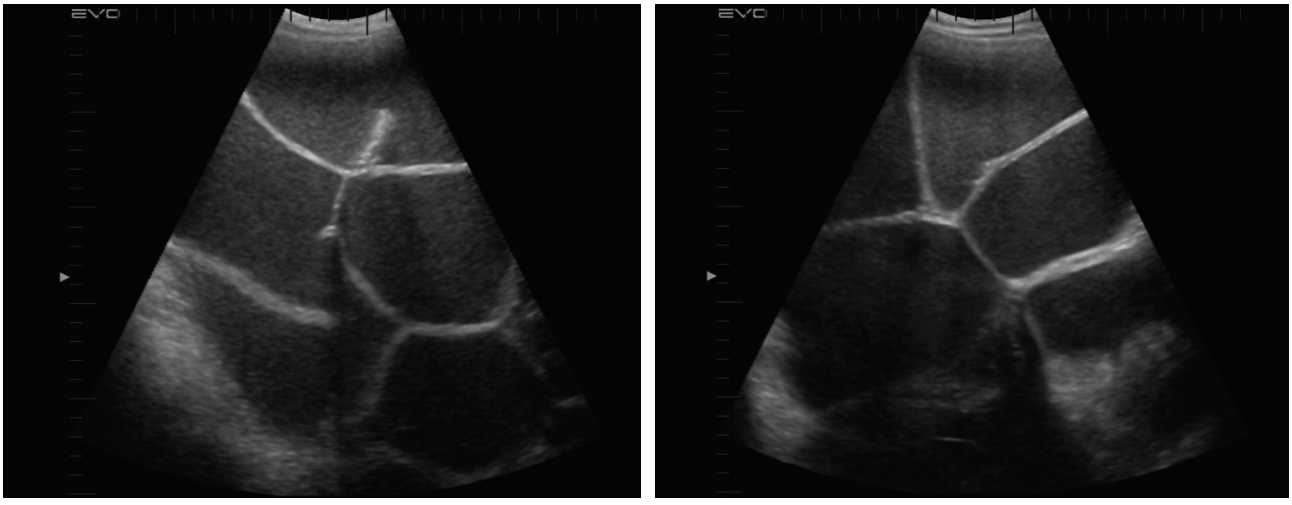

Figure 1. Transabdominal ultrasonographic images of the sow's uterus on second examination. Note multiple loops of homogenous hyperechoic fluid.

Citation line: Clinical Theriogenology 2023, 15, 9806, http://dx.doi.org/10.58292/CT.v15.9806

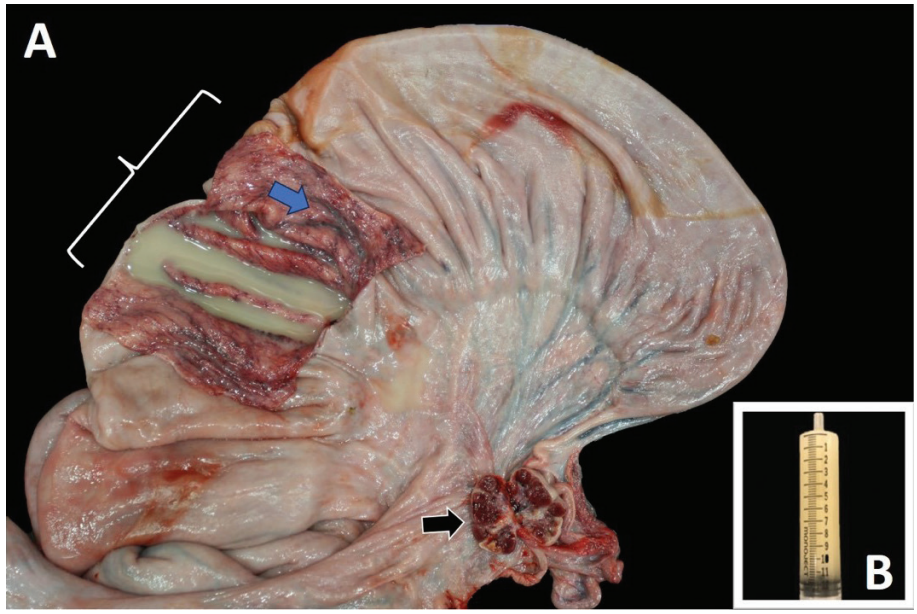

Figure 2. Gross photo of the sow's uterus and uterine fluid. A: Note red mucosal surface (bracket) with prominent, congested vasculature (blue arrow) and numerous corpora lutea on the left ovary (black arrow). B: After incising along the greater curvature, a copious amount of opaque, pale-yellow, watery fluid was released.

intestines and liver. The lumen contained a watery, off-white, turbid, slightly sour-smelling fluid (Figure 2B). The mucosal surface of the uterus was diffusely dark red with prominent vessels (Figure 2A). The oviducts were moderately thickened. The left ovary had multiple corpora lutea (CLs) (Figure 2A) and the right ovary had multiple corpora albicantia (CAs). The sublumbar and pelvic lymph nodes were markedly enlarged, lobulated, and measured 2 × 3 × 2 cm. The lymph node immediately adjacent to uterus within pelvis contained green, desiccated creamy material on cut section. The stomach contained watery, bright yellow contents. Mucosa around the pars esophageal region was irregular and flaky.

Bacteriology

Specimen type	Culture type	Results
Uterine fluid	Aerobic	*Actinomyces hyovaginalis*, moderate numbers
	Anaerobic	None detected
Lymph node swab	Aerobic	*Proteus* swarming

Histology

Tissue	Histologic findings
Stomach	Pars esophageal region of the stomach was covered by amphophilic material (interpreted as mucin) and hemorrhage. A regional defect of the mucosa was noted with the surrounding lamina propria being expanded by lymphocytes and plasma cells admixed with a smaller number of neutrophils.
Uterus	Endometrial glands were variably dilated by clear space and scant to moderate amounts of granular, eosinophilic fluid and/or viable and degenerate epithelial cells. Submucosa was markedly expanded by large numbers of plasma cells admixed with fewer lymphocytes and neutrophils. Traversing the mucosa were moderate numbers of neutrophils. Submucosal and myometrial vessels were markedly congested (Figure 3).
Kidney	Tubules were variably ectatic and empty or filled with hyaline casts. Interstitium was multifocally infiltrated by small numbers of lymphocytes and plasma cells. One glomerulus had increased mesangium and vessels containing globular eosinophilic material.
Left ovary	Multiple corpora lutea, corpora albicantia, developing follicles (Figure 4).

Immunohistochemistry

A porcine serology-based abortion panel was negative for antibodies to *Leptospira bratislava*, *L. canicola*, *L. grippotyphosa*, *L. hardjo*, *L. icterohaemorrhagiae*, and *L. pomona*, porcine parvovirus (PPV), pseudorabies virus (PRV), and *Brucella abortus*.

Cytology

Interpretation: Marked neutrophilic and lymphoplasmacytic inflammation with polymicrobial bacterial sepsis and unremarkable to hyperplastic uterine epithelium

Description: Wright Geimsa stained smear was highly cellular with a patchy pale blue background, many free cell nuclei, and numerous heterogeneous bacteria of mixed morphology (rods and cocci). Highly degenerate neutrophils were observed, often containing bacteria similar to that noted in the background, admixed with plasma cells, sometimes in small aggregates, small lymphocytes, and occasionally larger lymphocytes (Figure 5). Several mildly disrupted clusters of cuboidal to columnar epithelial cells were also appreciated. These cells had a moderate amount of mid-blue cytoplasm with distinct cell margins. Nuclei were ovoid, often polarized, with coarsely stippled chromatin and single small nucleoli. Nuclear to cytoplasmic ratios were moderate to high with mild anisocytosis and anisokaryosis.

Discussion

Definitions of uterine disease are not well established or widely accepted in sows compared to other species, which makes clinical diagnosis and differentiation of uterine disease challenging. Regardless, impaired fertility from reproductive disorders (including any uterine, ovarian, endocrine, vaginal, or vulvar condition resulting in an inability to conceive and maintain a pregnancy to term), accounts for up to one-third or more of all swine culling indications.[1–7] Outwardly, reproductive disease usually presents as failure to conceive, increased returns to estrus, anestrus, or abortion. Diagnosis of reproductive disorders can be aided by transabdominal ultrasonography, but this also presents many challenges and limitations because it is normal to visualize fluid within the uterus after breeding, during estrus, or associated with pregnancy; however, any fluid present in the uterus outside of these times is considered abnormal.[8] In many species, it is common to classify uterine disease into categories such as pyometra, metritis, and endometritis based on the presence of fluid, evaluation of fluid via transabdominal ultrasonography and/or cytology, vaginal and/or vulvar discharge and ovarian structures.

Defining characteristics of pyometra in any species are an accumulation of purulent fluid within the uterine lumen[9] and usually the presence of a functional corpus luteum (CL) that maintains a functionally closed cervix and prevents expulsion of the suppurative material.[10] Clinically, pyometra can be differentiated from pregnancy fluid based on B-mode real-time ultrasonography and fluid echogenicity.[11] In dairy cows, pyometra is often the result of ovulation occurring before uterine involution is complete that results in the formation of a corpus luteum and closure of the cervix before the uterus is cleared of all pathogens.[12] In both dairy and beef cows, pyometra can also result from pathogen introduction during insemination or breeding, as can be the case with *Tritrichomonas foetus* infections.[12] In canines, pyometra occurs frequently in conjunction with cystic endometrial hyperplasia due to the effects of progesterone on the uterine lining during the diestrus stage of the female cycle.[13,14] Female dogs have an extended luteal phase, in comparison to livestock species, as it is similar in length to that of pregnancy;[13] as a result, the pyometra is proposed to be a result of bacterial infection of the progesterone-primed endometrium.[10] In mares, pyometra is also defined as the presence of purulent fluid in the uterus with or without the presence of a CL. This condition can be further complicated by endogenous or exogenous mediated closure of the cervix, the presence of endometrial cups, or poor physical abilities of the uterus to drain in this species.[15] In sows, pyometra is often a sequela to endometritis or metritis[9] and can be differentiated from other uterine diseases by cytologic fluid analysis, but this condition is uncommon in this species[9,10], therefore cytological definitions of pyometra are not well established.

Metritis is defined as inflammation of all layers of the uterus.[9,10,16,17] In cows, metritis is characterized by malodorous fluid and myometrial edema, occurring within 2–3 weeks after calving, and usually does not cause systemic disease. Systemically affected cows with metritis are usually termed as having septic and/or toxic metritis, which has different treatments and implications than a metritis localized to the uterus.[12] In female dogs, metritis is a disease of the puerperal period and occurs 0–7 days after whelping frequently resulting in systemic illness.[18] In mares, metritis also extends through the uterine wall, making equids more prone to developing perimetritis and peritonitis which can lead to laminitis and septicemia.[19] Diagnosis of metritis in sows is based on the accumulation of uterine fluid and increased uterine size during the involution process.[20] It is usually observed within 24–48 hours after parturition[16] with fetid, malodorous vaginal discharge. Examination of the uterus postmortem often reveals a uterus distended by purulent fluid mixed with necrotic material. Sows are often systemically affected, presenting with vague signs such as inappetence and fever. Histologically, edema and bacterial infiltration of the uterine wall may be present along with edema and purulent exudate within the myometrium itself.[16] Deep infiltration into the myometrium in sows resulting in metritis is rare.[21]

Endometritis is defined as inflammation that is limited to the endometrium.[10] In cows, endometritis is limited to the mucosal and submucosal layers of the uterus and does not cause systemic illness. Classifications of clinical and subclinical endometritis in cows have recently been proposed, depending on the presence of discharge or lack thereof, respectively, and is limited to diagnosis in animals > 21 days after calving, as cows have an extended uterine involution period.[12] In female dogs, endometritis may present as part of a cystic endometrial hyperplasia-pyometra complex[14] or on its own as a source of infertility.[22] In sows, endometritis is associated with infertility that can be either temporary or permanent.[23] In mares, a transient postcoital endometritis is commonly observed after breeding,[10] that depending on the severity and persistence of fluid, may require intervention to resolve. Endometritis can also be observed after foaling, after artificial insemination, or due to poor conformation.[19] Endometritis has been cited as the most common inflammatory process affecting the porcine uterus. Sows can present with and without vaginal or vulvar discharge and with or without return to estrus.[1,24,25] Inconsistent presentation and lack of systemic illness in this species are challenges for the diagnostician.[16] In addition to classification based on clinical appearance as discussed above, endometritis can also be defined and differentiated based on the cellular infiltration of the uterus on histological examination and timing in relation to parturition and breeding.

Endometritis in sows can be classified as puerperal or nonpuerperal,[8,25] and further into acute, subacute, and chronic.[10,21,26–29] Before these classifications were available, endometritis in the sow was classified based on the presence of uterine fluid but not defined histologically.[1,24] In addition to uterine fluid classifications, acute and subacute

endometritis are more likely to present with a vulvar discharge, whereas chronic endometritis may be more difficult to diagnose outwardly other than failure to conceive or maintain a pregnancy which manifests clinically as increased returns to estrus.[2,21,25,30] An additional scale consisting of mild, mild to moderate, moderate, and severe has been published, taking into consideration leukocyte infiltration and endometrial changes.[30] No standard definitions of acute, subacute, and chronic nonpuerperal endometritis have been established; however, several criteria have been published. Cell types and numbers present in the endometrium as well as damage to normal structures have been proposed as a system to differentiate acute, subacute, or chronic endometritis (Table 1).[1,21,26,27,29,30]

When evaluating cellular infiltration in sows, stage of the estrous cycle must also be considered. Pathologic cellular infiltration versus normal cellular infiltration at different phases of the estrous cycle will vary. Depending on the phase of the estrous cycle, it can be normal for fluid to be present; so, if the information is available, histologic, visual, and/or ultrasonographic evaluation should consider ovarian structures.[26,27] Unlike diestrus, estrus presents a more active type of cellular migration with an open cervix due to the effects of estrogen. It is normal to observe increased numbers of neutrophils and lymphocytes. Despite the cell types, focal accumulations of cells and destruction of normal architecture (e.g. uterine glandular epithelium) are considered pathological.[7,29] General guidelines on cell types observed normally during different stages of the sow estrous cycle are presented (Table 2).

In addition to outward clinical signs and cytologic examination to classify endometritis in sows, transabdominal

Table 1. Proposed histologic definitions of acute, subacute, and chronic endometritis in the sow.

Disease definition	Cell types
Normal	Maximum of 15 inflammatory cells per field (400 x) during estrus or metestrus[26]
Acute endometritis	No further classification within acute endometritis • > 100 neutrophils per 20 high power fields (hpfs [400 x])[27] • > 20 neutrophils for estrous females and > 5 for diestrous females in subepithelial layer and/or any neutrophils present in the stromal layer[2] • > 20 neutrophilic granulocytes per hpf[7]
	Moderate • Number of neutrophilic granulocytes substantially higher than normally observed without other abnormalities[29] • >20 neutrophilic granulocytes per hpf with no alterations to the endometrium[26]
	Severe • Number of neutrophilic granulocytes substantially higher than normally observed in conjunction with endometrial damage[29] • > 40 neutrophilic granulocytes cells per hpf with alterations to the endometrium[26]
Subacute endometritis	• Increased neutrophilic granulocytes and lymphocytes[26,29] • 40–100 neutrophils with > 10 plasma cells per 20 hpfs[27]
Acute-chronic endometritis	Simultaneous appearance of: • > 15 lymphocytes within the subepithelial later and/or > 5 lymphocytes within the stromal layer and/or > 5 plasma cells within one or both layers regardless of the stage of the cycle[2] • > 20 neutrophils for estrous females and > 5 for diestrous females in subepithelial layer and/or any neutrophils present in the stromal layer[2]
Chronic endometritis	No further classification within chronic endometritis • Lymphocytes, plasma cells, and histiocytes substantially higher than normal[29] • > 20 lymphocytes, plasma cells, histiocytes per hpf [26] • > 40 lymphocytes, > 10 plasma cells, and < 20 neutrophils per 20 hpfs in subepithelial layers[27] • > 15 lymphocytes within the subepithelial later and/or >5 lymphocytes within the stromal layer and/or > 5 plasma cells within one or both layers regardless of the stage of the cycle[2]
	Mild • > 5 lymphocytes per hpf in subepithelial layer and/or > 15 lymphocytes per hpf in lamina propria[21]
	Severe • Dense infiltration of lymphocytes and plasma cells[21]

Table 2. Normal cell types observed in porcine uterus by phase of the estrous cycle.

Cell type	Phase of estrous cycle	
	Proestrus, estrus (follicular)	**Diestrus (luteal)**
Neutrophils	Increased number of neutrophilic granulocytes[26,29] High infiltration of neutrophils at proestrus and estrus in the subepithelial layer[31]	Neutrophilic granulocytes almost absent[26,29] Rarely observed in the glandular layer[31] Substantially lower neutrophils during the luteal phase[27]
Lymphocytes	Increased numbers[26,29] Substantially increased numbers of intraepithelial lymphocytes with round nucleus[31] Largest number of lymphocytes in the subepithelial layer[31] Substantially increased numbers of lymphocytes[27]	High numbers during early diestrus and low numbers during late diestrus[31] Low numbers[26,29]
Plasma cells	Substantially increased numbers of plasma cells in subepithelial and connective tissue layers[27]	Almost absent[29]
Macrophages	Most macrophages were observed at estrus[31]	Macrophages observed in early diestrus in subepithelial and glandular layer[31] Substantially higher in the subepithelial and the glandular tissue layers of the endometrium[27]
Other cell types	Mast Cells Mast cells in the subepithelial layer[31]	Eosinophils Low numbers of eosinophilic granulocytes[26,29] Largest number of eosinophils during diestrus compared to other stages in the subepithelial layer[31] Rarely observed in the glandular layer[31] Substantially higher in the subepithelial and the glandular tissue layers of the endometrium[27]

ultrasonography has also been used, but there is no clear definition of the ultrasonographic appearance of endometritis in this species. In diestrus, when the cervix is closed and the uterus is under the influence of progesterone (quiescent), there should not be any intraluminal fluid and uterine wall should appear homogenous.[28] If fluid is present with endometritis, there are many different documented descriptions ranging from anechoic with no definitive form[24] to a heterogenous echogenic fluid resembling a snow flurry.[8] Some differentiate the types of endometritis (acute, acute-chronic, and chronic) based on the type of fluid that is visible, indicating that fluid can be observed ultrasonographically if endometritis is either acute or acute-chronic.[26,27] Severe acute endometritis is described as more of the snow flurry, flocculent fluid type,[25,28] whereas chronic endometritis can have a wide range of appearances. Because of this, it has been argued that there is no relationship between chronic endometritis and ultrasonographic uterine size or echotexture.[2] Further, chronic endometritis cannot be definitively diagnosed by ultrasonographically because it can appear similar to normally involuted uterus.[2,8,28] Because there is no consensus, interpretation of uterine imaging findings should be performed in conjunction with ovarian findings to help interpret whether ovarian findings are consistent with normal variations in uterine echotexture based on circulating hormones or if the two are in opposition.[8,25]

In terms of systemic manifestations of uterine disease, elevated core temperatures in conjunction with other signs of systemic illness (lethargy, inappetence), as observed in this case, have been associated with endometritis in sows.[7,32,33] In addition to endometritis, this sow had gross and histologic evidence of salpingitis. This is not surprising given that uterine infections are a commonly reported source of oviductal disease.[25] Urinary bladder in this case was unremarkable; however, pigs with cystitis are 3.5 times more likely to develop endometritis due to the urethral connection between the urinary and genital tracts.[7] Interstitial nephritis was observed histologically, but this is a nonspecific finding and was not associated with pyelonephritis to indicate an ascending infection from the grossly normal urinary bladder. Regionally extensive erosion of the stomach likely contributed to the sow's decline but is likely secondary to other disease processes.

In terms of specific pathogens of endometrial disease in swine, most are bacterial in origin. Viral pathogens causing uterine disease in sows are rare. Bacterial pathogens in endometritis include gram-negative pathogens (e.g. *Escherichia coli*, *Klebsiella* spp., *Chlamydia* spp., or *Proteus* spp.) and gram-positive pathogens (e.g. *Staphylococcus* spp., *Trueperella pyogenes*, *Streptococcus* spp., and *Enterococcus*

Citation line: Clinical Theriogenology 2023, 15, 9806, http://dx.doi.org/10.58292/CT.v15.9806

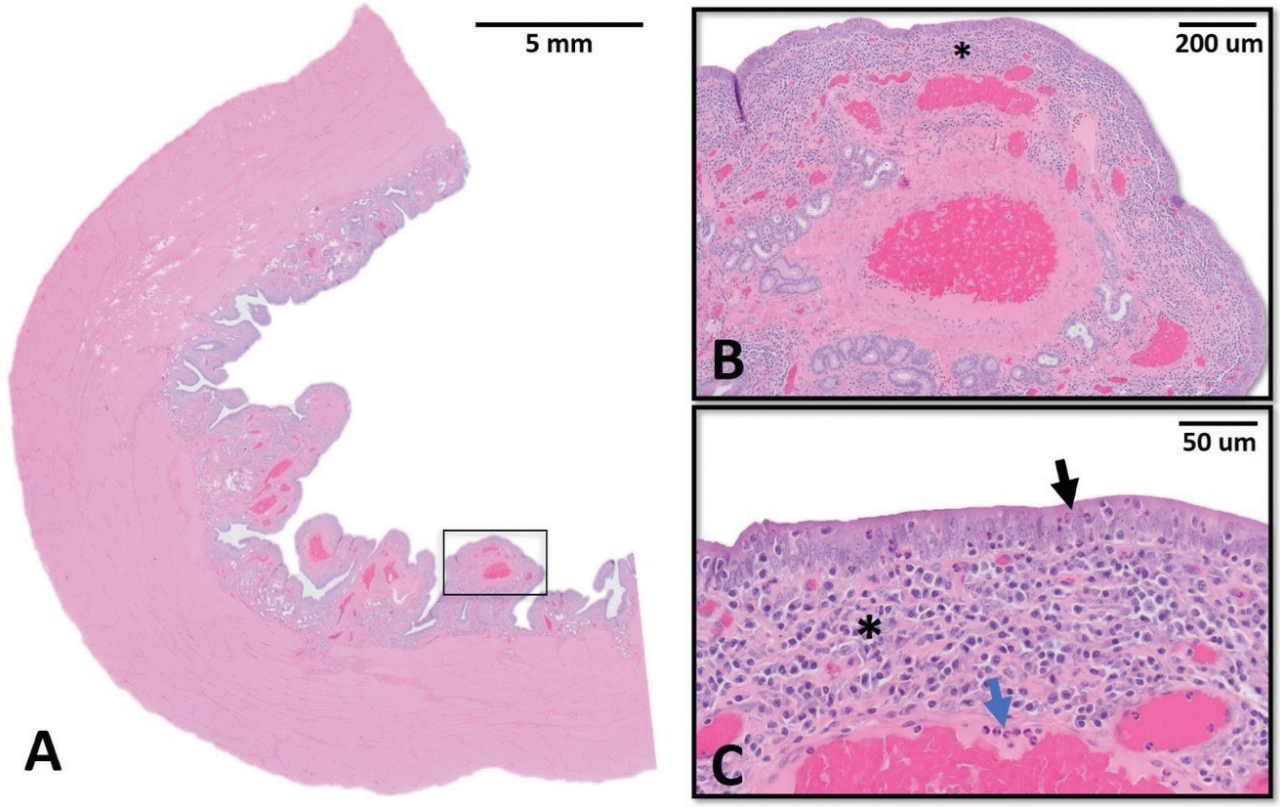

Figure 3. Histologic images of the sow's uterine horns. (A) Subgross hematoxylin and eosin (H&E) image of a uterine horn in which the submucosa and overlying hyperplastic mucosa form multiple folds resembled papillary projections. (B) at higher magnification, the submucosa appeared expanded by sheets of inflammatory cells (asterisk) with markedly congested blood vessels. (C) A higher magnification of the mucosal surface demonstrated a dense infiltration of plasma cells (asterisk) with neutrophils traversing the epithelial surface (black arrow) and marginating within blood vessels (blue arrow).

spp.). Specifically, *Staphylococcus aureus, Staphylococcus hyicus, streptococcus suis,* and *Streptococcus equisimilis*[1,7,25–27] have been implicated as causes of endometrial disease in sows. In this case, culture of *Actinomyces hyovaginalis* from uterine fluid is unusual, as this is not considered a major pathogen of endometritis in sows or gilts. *Actinomyces* spp. are facultatively anaerobic, gram positive, slow growing bacteria that have been isolated as normal flora from a variety of anatomical sites in both human and veterinary medicine, including skin and oral mucosa.[25,34] In veterinary medicine, *Actinomyces hyovaginalis* specifically has been cultured from swine necrotic lung abscesses[35] as well as a tracheobronchial lymph node in a goat.[36] Other species of *Actinomyces* have been implicated in a variety of conditions in veterinary medicine. For example, *Actinomyces bovis* is a normal inhabitant of the bovine oral microflora and is the causative agent of mandibular osteomyelitis ('lumpy jaw') in cattle.[10] In swine, *Actinomyces hyovaginalis* has been associated with sporadic abortions and embolic pneumonia.[25] It is thought to be a normal inhabitant of the vaginal flora of pigs (specifically biovar Type II) and has been isolated in vaginal discharge and aborted fetal cultures. It is likely that *Actinomyces hyovaginalis* associated disease is likely underreported.[25] In a study where gilts underwent intrauterine inoculation of *Actinomyces* spp., 1 developed no clinical signs and another developed severe acute endometritis.[26] Because this organism is a normal inhabitant of the vagina, its presence alone in vaginal swabs or on aborted fetuses does not imply that it is the causative agent of disease; however, culture from uterine fluid in conjunction with the uterine disease is more relevant.

This case was classified as chronic endometritis complicated by pyometra after taking into consideration existing proposed definitions of uterine disease, histological and cytological evaluations, and most likely estrous cycle stage. Grossly and histologically observed CLs (Figure 4) likely resulted in cervical closure and intrauterine fluid accumulation, consistent with pyometra (Figure 2). Accumulation of uterine fluid along with lymphoplasmacytic infiltration and lack of vulvar discharge is consistent with definitions of chronic endometritis. With this classification, it is important to take into consideration both the histologic and ovarian findings in addition to ultrasonographic findings. It is unknown in this case whether the CLs would have persisted pathologically if the animal was not euthanized or if the sow was in the middle of a normal luteal phase that would have resulted in luteolysis of the grossly observed CLs. Additionally, another challenge for interpretation in this case is whether a bacterial infection during copulation/insemination resulted in endometritis and early embryonic loss, or whether the animal had an underlying, clinically silent endometritis and then ovulated with an already compromised endometrium, causing closure of the cervix and accumulation of intrauterine fluid. Histologic examination of the tissues demonstrated a dense infiltrate of predominantly plasma cells, consistent with chronic endometritis (Figure 3, Table 1); however, the clinical presentation

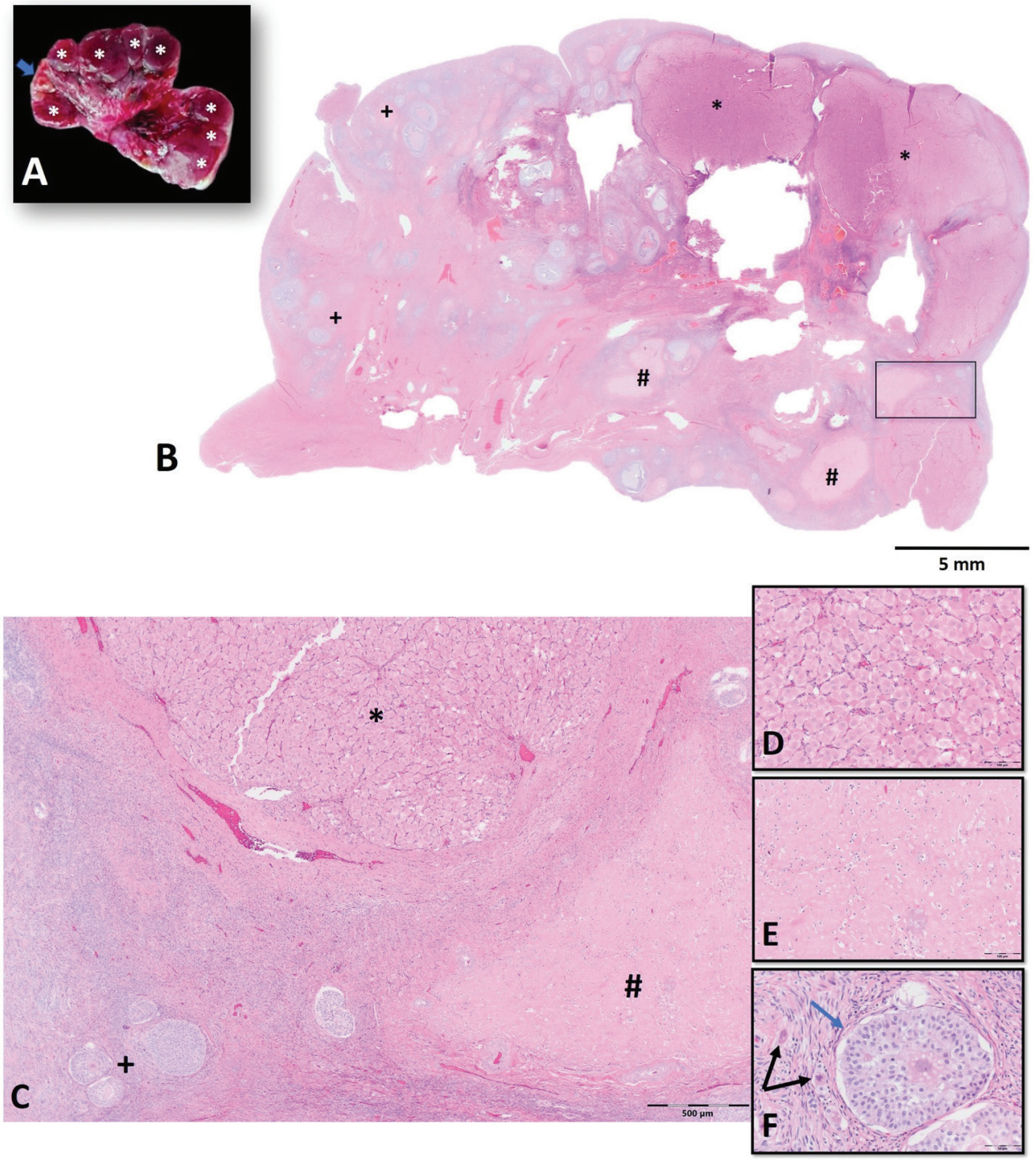

Figure 4. Gross and histologic images of the sow's left ovary. A: Gross image of the medially incised ovary demonstrating numerous corpora lutea (white *) and a corpora albicans (blue arrow). Subgross (B) and higher magnification (C) images of a H&E-stained section of ovary with corpora lutea (black *), developing follicles (+), and a corpora albicans (#). D: High magnification image of luteal cells with foamy cells containing steroid hormones. E: High magnification image of a an involuted corpus luteum (corpus albicans), that appeared white due to the presence of fibroblasts and collagen. F: Scattered amongst the normal fibromuscular ovarian stroma are various developing follicles. Black arrows designate primordial follicles consisting of a primary oocyte with a single layer of squamous cells. Larger follicle is a secondary follicle (blue arrow) with a primary oocyte surrounded by multiple layers of granulosa cells that are variably supported by theca folliculi (encasement of rich blood supply and connective tissue).

Citation line: Clinical Theriogenology 2023, 15, 9806, http://dx.doi.org/10.58292/CT.v15.9806

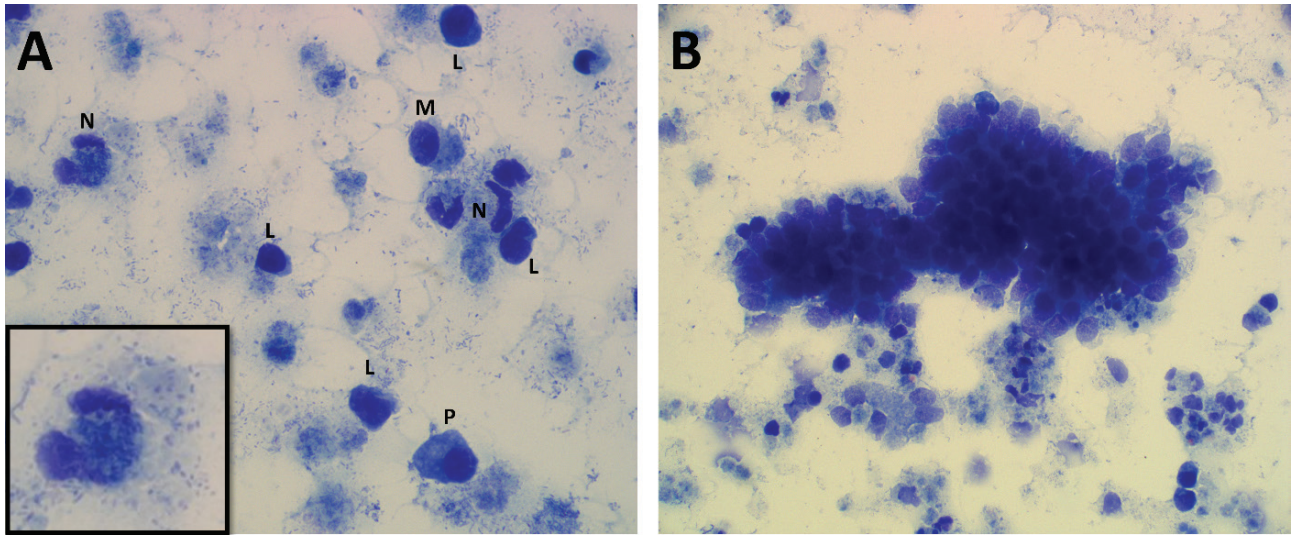

Figure 5. A: Cytologically, uterine fluid was highly cellular with a patchy, pale blue background, numerous heterogenous bacteria of mixed morphology and inflammatory cells consisting of highly degenerate neutrophils often containing bacteria (N and inset) admixed with plasma cells (P), small and large lymphocytes (L), and rarely macrophages (M). B: Several clusters of cuboidal to columnar epithelial cells were also appreciated.

and purulent fluid also fulfill the definition of pyometra (Figure 5). Therefore, the classification of uterine disease in this sow is chronic endometritis (Figure 3) and pyometra. Systemically, considering the elevated temperature and adjacent lymph node enlargement, it is possible that the sow was septic and bacterial showering resulted in nephritis, increased temperature, and lymphadenopathy, all contributing to her outward clinical decline.

Learning points

- There are no standard definitions of different types of uterine disease in swine
- Reproductive disease is a substantial cause of culling in sows
- Classification of endometritis in sows is challenging due to differences in immune cells during different stages of the estrous cycle and inconsistent uterine appearance on ultrasonography

Conflict of interest

None to report.

References

1. Muirhead M: Epidemiology and control of vaginal discharges in the sow after service. Vet Rec 1986;119:233–235. doi: 10.1136/vr.119.10.233
2. Kauffold J, Rautenberg T, Hoffmann G, et al: A field study into the appropriateness of transcutaneous ultrasonography in the diagnoses of uterine disorders in reproductively failed pigs. Theriogenology 2005;64:1546–1558. doi: 10.1016/j.theriogenology.2005.03.022
3. Heinonen M, Leppavuori A, Pyorala S: Evaluation of reproductive failure of female pigs based on slaughterhouse material and herd record survey. Anim Reprod Sci 1998;52:235–244. doi: 10.1016/s0378-4320(98)00105-5
4. D'allaire S, Stein TE, Leman AD: Culling patterns in selected Minnesota swine breeding herds. Can J Vet Res 1987;51:506–512.
5. Anil S, Anil L, Deen J: Evaluation of patterns of removal and associations among culling because of lameness and sow productivity traits in swine breeding herds. J Am Vet Med Assoc 2005;226:956–961. doi: 10.2460/javma.2005.226.956
6. Wang C, Wu Y, Shu D, et al: An analysis of culling patterns during the Breeding Cycle and lifetime production from the aspect of culling reasons for gilts and sows in southwest China. Animals 2019;9:1–9. doi: 10.3390/ani9040160
7. Grahofer A, Björkman S, Peltoniemi O: Diagnosis of endometritis and cystitis in sows: use of biomarkers. J Anim Sci 2020;98:S107–S116. doi: 10.1093/JAS/SKAA144
8. Kauffold J, Althouse GC: An update on the use of B-mode ultrasonography in female pig reproduction. Theriogenology 2007;67:901–911. doi: 10.1016/j.theriogenology.2006.12.005
9. Foster RA: Female reproductive system and mammae. In: Zachary JF, McGavin MD, editors. Pathologic Basis of Veterinary Disease. 6th edition, St. Louis, Missouri: Elsevier; 2017, p. 1147–1193.
10. Schlafer DH, Foster RA: Female genital system. In: Maxie MG, editor. Jubb, Kennedy, and Palmer's Pathology of Domestic Animals, volume 3. 6th edition, St. Louis, Missouri: Elsevier; 2016, p. 358–464.
11. Knox R V, Althouse GC: Visualizing the reproductive tract of the female pig using real-time ultrasonography. J Swine Health Prod 1999;7:207–215.
12. Dadarwal D, Palmer C: Postpartum uterine infection. In: Hopper RM, editor. Bovine Reproduction. 1st edition, Hoboken, NJ, USA: John Wiley & Sons, Inc; 2014, p. 639–654. doi: 10.1002/9781118833971

13. Concannon PW: Reproductive cycles of the domestic bitch. Anim Reprod Sci 2011;124:200–210. doi: 10.1016/j.anireprosci.2010.08.028
14. Johnston SD, Root Kustritz M V, Olson PNS: Disorders of the canine uterus and uterine tubes (oviducts). In: Canine and Feline Theriogenology. 1st edition, Philadelphia, PA, USA: Saunders; 2001, p. 206–224.
15. Lu KG: Pyometra. In: McKinnon AO, Squires EL, Vaala WE, et al, editors. Equine Reproduction, volume 2. 2nd edition, Ames, Iowa: Wiley-Blackwell; 2010, p. 2652–2654.
16. Fangman TJ, Shannon MC: Diseases of the puerperal period. In: Youngquist RS, Threlfall WR, editors. Current Therapy in Large Animal Theriogenology. 2nd edition, St. Louis, Missouri: Elsevier; 2007, p. 784–788. doi: 10.1016/B978-0-7216-9323-1.X5001-6
17. Garzon A, Habing G, Lima F, et al: Defining clinical diagnosis and treatment of puerperal metritis in dairy cows: a scoping review. J Dairy Sci 2022;105:3440–3452. doi: 10.3168/jds.2021-21203
18. Johnston SD, Root Kustritz M V, Olson PNS: Periparturient disorders in the bitch. In: Canine and Feline Theriogenology. 1st edition, Philadelphia, PA, USA: Saunders; 2001, p. 129–145.
19. Brinsko SP, Blanchard TL: Manual of equine reproduction. St. Louis, Missouri: Mosby/Elsevier; 2011.
20. Björkman S, Oliviero C, Kauffold J, et al: Prolonged parturition and impaired placenta expulsion increase the risk of postpartum metritis and delay uterine involution in sows. Theriogenology 2018;106:87–92. doi: 10.1016/j.theriogenology.2017.10.003
21. Dalin AM, Kaeoket K, Persson E: Immune cell infiltration of normal and impaired sow endometrium. Anim Reprod Sci 2004;82–83:401–413. doi: 10.1016/j.anireprosci.2004.04.012
22. Angela T. Gifford, Janet M, et al: Histopathologic findings in uterine biopsy samples from subfertile bitches: 399 cases (1990–2005). J Am Vet Med Assoc 2014;244:180–186. doi: 10.2460/javma.244.2.180
23. Dial GD, MacLachlan NJ: Urogenital Infections of Swine. Part I. Clinical Manifestations and Pathogenesis. Compendium Food Animal 1988;10:63–70.
24. Martinez E, Vazquez JM, Roca J, et al: Use of real-time ultrasonic scanning for the detection of reproductive failure in pig herds. Anim Reprod Sci 1992;29:53–59. doi: 10.1016/0378-4320(92)90019
25. Althouse GC, Kauffold J, Rossow S, et al: Diseases of the reproductive system. In: Zimmerman JJ, Karriker LA, Ramirez A, et al: editors. Swine Reproduction. 11th edition, Hoboken, NJ: John Wiley & Sons, Inc; 2019, p. 373–393.
26. de Winter P, Verdonck M, de Kruif A, et al: Bacterial endometritis and vaginal discharge in the sow: prevalence of different bacterial species and experimental reproduction of the syndrome. Anim Reprod Sci 1995;37:325–335. doi: 10.1016/0378-4320(94)01342
27. Tummaruk P, Kesdangsakonwut S, Prapasarakul N, et al: Endometritis in gilts: reproductive data, bacterial culture, histopathology, and infiltration of immune cells in the endometrium. Comp Clin Path 2010;19:575–584. doi: 10.1007/s00580-009-0929-1
28. Kauffold J, Peltoniemi O, Wehrend A, et al: Principles and clinical uses of real-time ultrasonography in female swine reproduction. Animals 2019;9:1–17. doi: 10.3390/ani9110950
29. de Winter PJJ, Verdonck M, de Kruif A: Endometritis and vaginal discharge in the sow. Anim Reprod Sci 1992;28:51–58. doi: 10.1016/0378-4320(92)90091
30. Dalin AM, Gidlund K, Eliasson-Selling L: Post-mortem examination of genital organs from sows with reproductive disturbances in a sow-pool. Acta Vet Scand 1997;38:253–262. doi: 10.1186/BF03548488
31. Kaeoket K, Persson E, Dalin AM: The sow endometrium at different stages of the oestrous cycle: studies on morphological changes and infiltration by cells of the immune system. Anim Reprod Sci 2001;65:95–114. doi: 10.1016/s0378-4320(00)00211-6
32. Meile A, Nathues H, Kauffold J, et al: Ultrasonographic examination of postpartum uterine involution in sows. Anim Reprod Sci 2020;219:1–7. doi: 10.1016/j.anireprosci.2020.106540
33. Stiehler T, Heuwieser W, Pfutzner A, et al: The course of rectal and vaginal temperature in early postpartum sows. J Swine Health Prod 2015;23:72–83.
34. Valour F, Sénéchal A, Dupieux C, et al: Actinomycosis: etiology, clinical features, diagnosis, treatment, and management. Infect Drug Resist 2014;7:183–197. doi: 10.2147/IDR.S39601
35. Aalbaek B, Christensen H, Bisgaard M, et al: Actinomyces hyovaginalis associated with disseminated necrotic lung lesions and slaughter pigs. J Comp Pathol 2003;129:70–77. doi: 10.1016/S0021-9975(03)00005-7
36. Schumacher VL, Hinckley L, Gilbert K, et al: Actinomyces hyovaginalis-associated lymphadenitis in a Nubian goat. J Vet Diagn Invest 2009;21:380–384. doi: 10.1177/104063870902100315